

## CLAIMS

What is claimed is:

- 1           1.       An optical apparatus for transmitting an optical signal,  
2 comprising:  
3           a static filter that has wavelength dependent transmission;  
4           a Faraday rotator;  
5           a reflector; and  
6           wherein the Faraday rotator makes a first change in polarization of  
7 the optical signal in a first direction and a second change in polarization of  
8 the optical signal received from the reflector in a second direction to  
9 produce a polarization of the optical signal that is substantially orthogonal  
10 to an initial polarization state of the optical signal.
- 1           2.       The apparatus of claim 1, wherein the Faraday rotator has a  
2 nominally 45° rotation for linear polarization.
- 1           3.       The apparatus of claim 1, further comprising:  
2 a lens positioned to image the optical signal to an optical fiber.
- 1           4.       The apparatus of claim 3, wherein the lens is positioned  
2 between the optical fiber and the static filter.
- 1           5.       The apparatus of claim 3, wherein the lens is positioned  
2 between the static filter and the Faraday rotator.
- 1           6.       The apparatus of claim 3, wherein the lens is positioned  
2 between the Faraday rotator and the reflector.
- 1           7.       The apparatus of claim 1, wherein the reflector is a high  
2 reflector.

1           8.       The apparatus of claim, wherein the reflector reflects at least  
2   50% of incident light.

1           9.       The apparatus of claim 1, wherein the static filter includes  
2   dielectric films and a transparent substrate.

1           10.      The apparatus of claim 1, wherein the static filter is an  
2   interference filter.

1           11.      The apparatus of claim 1, wherein the static filter is a fiber  
2   based filter.

1           12.      The apparatus of claim 1, wherein the static filter is a  
2   waveguide filter.

1           13.      The apparatus of claim 1, further comprising:  
2   a mode coupler coupled to an optical fiber and configured to create  
3   perturbations in the optical modes in the optical fiber and provide coherent  
4   coupling between two modes in the optical fiber.

1           14.      The apparatus of claim 13, wherein the optical fiber has a  
2   cladding surrounding a core.

1           15.      The apparatus of claim 13, wherein the mode coupler is  
2   selected from an acoustic grating, a UV grating, a bending grating and a  
3   stress induced grating.

1           16.      The apparatus of claim 13, wherein the mode coupler  
2   includes an acoustic wave generator and an acoustic wave propagation  
3   member coupled to the optical fiber.

1           17.      The apparatus of claim 13, wherein the mode coupler couples  
2   a first core mode to a second core mode.

1           18.     The apparatus of claim 13 wherein the mode coupler couples  
2     a core mode to a cladding mode.

1           19.     The apparatus of claim 13 wherein the mode coupler couples  
2     a cladding mode to a core mode.

1           20.     -The apparatus of claim 13 wherein the mode coupler couples  
2     a cladding mode to a different cladding mode.

1           21.     The apparatus of claim 13 wherein the mode coupler includes  
2     an acoustic wave generator that produces multiple acoustic signals with  
3     individual controllable strengths and frequencies, each of the acoustic  
4     signals providing a coupling between different modes traveling within the  
5     optical fiber.

1           22.     The apparatus of claim 13, wherein the mode coupler  
2     includes a temperature controlled grating that is temperature tunable.

1           23.     The apparatus of claim 13, wherein the mode coupler  
2     includes a stress induced grating that is stress tunable.

1           24.     The apparatus of claim 13, wherein the mode coupler  
2     includes an acoustic wave generator that produces longitudinal waves.

1           25.     The apparatus of claim 13, wherein the mode coupler  
2     includes an acoustic wave generator that produces torsional waves.

1           26.     The apparatus of claim 13, wherein the mode coupler  
2     includes an acoustic wave generator that produces transverse waves.

1           27.     The apparatus of claim 13, wherein the mode coupler  
2     includes an acoustic wave generator and a wavelength of an optical signal  
3     coupled between two different modes traveling within the optical fiber is

4 changed by varying the frequency of a signal applied to the acoustic wave  
5 generator.

1 28. The apparatus of claim 13, wherein the mode coupler  
2 includes an acoustic wave generator and an amount of an optical signal  
3 coupled between two different modes traveling within the optical fiber is  
4 changed by varying the amplitude of a signal applied to the acoustic wave  
5 generator.

1 29. An optical apparatus for transmitting an optical signal,  
2 comprising:  
3 a static filter that has wavelength dependent transmission;  
4 a Faraday rotator;  
5 a variable optical attenuator that attenuates at least a portion of the  
6 optical signal;  
7 a reflector; and  
8 wherein the Faraday rotator makes a first change in polarization of  
9 the optical signal in a first direction, and a second change in polarization of  
10 the optical signal received from the reflector in a second direction to  
11 produce a polarization of the optical signal that is substantially orthogonal  
12 to an initial polarization state of the optical signal.

1 30. The apparatus of claim 29, wherein the Faraday rotator has a  
2 nominally 45° rotation for linear polarization.

1 31. The apparatus of claim 29, further comprising:  
2 a lens positioned to image the optical signal to an optical fiber.

1 32. The apparatus of claim 29, wherein the variable optical  
2 attenuator is positioned between the static filter and the Faraday rotator.

1           33.     The apparatus of claim 29, wherein the variable optical  
2 attenuator is positioned between the Faraday rotator and the reflector.

1           34.     The apparatus of claim 31, wherein the variable optical  
2 attenuator is positioned between the lens and the static filter.

1           35.     The apparatus of claim 31, wherein the lens is positioned  
2 between the optical fiber and the static filter.

1           36.     The apparatus of claim 31, wherein the lens is positioned  
2 between the static filter and the Faraday rotator.

1           37.     The apparatus of claim 31, wherein the lens is positioned  
2 between the Faraday rotator and the reflector.

1           38.     The apparatus of claim 29, wherein the reflector is a high  
2 reflector.

1           39.     The apparatus of claim 29, wherein the reflector reflects at  
2 least 50% of incident light.

1           40.     The apparatus of claim 29, wherein the filter includes  
2 dielectric films and a transparent substrate.

1           41.     The apparatus of claim 29, wherein the filter is an  
2 interference filter.

1           42.     The apparatus of claim 29, wherein the filter is a fiber based  
2 filter.

1           43.     The apparatus of claim 29, wherein the filter is a waveguide  
2 filter.

- 1           44.     The apparatus of claim 29, further comprising:  
2                 a mode coupler coupled to an optical fiber and configured to create  
3 perturbations in the optical modes in the optical fiber and provide coherent  
4 coupling between a first mode to a second mode in the optical fiber.
- 1           45.     The apparatus of claim 44, wherein the optical fiber has a  
2 cladding surrounding a core.
- 1           46.     The apparatus of claim 44, wherein the mode coupler is  
2 selected from an acoustic grating, a UV grating, a bending grating and a  
3 stress induced grating.
- 1           47.     The apparatus of claim 44, wherein the mode coupler  
2 includes an acoustic wave generator and an acoustic wave propagation  
3 member coupled to the optical fiber.
- 1           48.     The apparatus of claim 44, wherein the mode coupler couples  
2 a first core mode to a second core mode.
- 3           49.     The apparatus of claim 44 wherein the mode coupler couples  
4 a core mode to a cladding mode.
- 1           50.     The apparatus of claim 44 wherein the mode coupler couples  
2 a cladding mode to a core mode.
- 1           51.     The apparatus of claim 44 wherein the mode coupler couples  
2 a cladding mode to a different cladding mode.
- 1           52.     The apparatus of claim 44 wherein the mode coupler includes  
2 an acoustic wave generator that produces multiple acoustic signals with  
3 individual controllable strengths and frequencies, each of the acoustic

4 signals providing a coupling between different modes traveling within the  
5 optical fiber.

1 53. The apparatus of claim 44, wherein the mode coupler  
2 includes a temperature controlled grating that is temperature tunable.

1 54. The apparatus of claim 44, wherein the mode coupler  
2 includes a stress induced grating that is stress tunable.

1 55. The apparatus of claim 44, wherein the mode coupler  
2 includes an acoustic wave generator that produces longitudinal waves.

1 56. The apparatus of claim 44, wherein the mode coupler  
2 includes an acoustic wave generator that produces torsional waves.

1 57. The apparatus of claim 44, wherein the mode coupler  
2 includes an acoustic wave generator that produces transverse waves.

1 58. The apparatus of claim 44, wherein the mode coupler  
2 includes an acoustic wave generator and a wavelength of an optical signal  
3 coupled between two different modes traveling within the optical fiber is  
4 changed by varying the frequency of a signal applied to the acoustic wave  
5 generator.

1 59. The apparatus of claim 44, wherein the mode coupler  
2 includes an acoustic wave generator and an amount of an optical signal  
3 coupled between two different modes traveling within the optical fiber is  
4 changed by varying the amplitude of a signal applied to the acoustic wave  
5 generator.

1 60. An optical apparatus for transmitting an optical signal,  
2 comprising:  
3 a static filter that has wavelength dependent transmission;

4 a Faraday rotator;  
5 a reflector positioned along a first optical path defined by the static  
6 filter, the Faraday rotator and the reflector, the reflector reflecting at least a  
7 portion of the optical signal back in a direction towards the Faraday rotator  
8 along an optical path that is not the first optical path; and  
9 wherein the Faraday rotator makes a first change in polarization of  
10 the optical signal received from the static filter, and a second change in  
11 polarization of the optical signal received from the reflector to produce a  
12 polarization of the optical signal that is substantially orthogonal to an initial  
13 polarization state of the optical signal.

1 61. The apparatus of claim 60, wherein the Faraday rotator has a  
2 nominally 45° rotation for linear polarization.

1 62. The apparatus of claim 60, further comprising:  
2 a lens positioned to image the optical signal to an optical fiber.

1 63. The apparatus of claim 62, wherein the lens is positioned  
2 between the optical fiber and the static filter.

1 64. The apparatus of claim 62, wherein the lens is positioned  
2 between the static filter and the Faraday rotator.

1 65. The apparatus of claim 62, wherein the lens is positioned  
2 between the Faraday rotator and the reflector.

1 66. The apparatus of claim 60, wherein the reflector is a high  
2 reflector.

1 67. The apparatus of claim 60, wherein the reflector reflects at  
2 least 50% of incident light.



1           68.    The apparatus of claim 60, wherein the static filter includes  
2   dielectric films and a transparent substrate.

1           69.    The apparatus of claim 60, wherein the static filter is an  
2   interference filter.

1           70.    The apparatus of claim 60, wherein the static filter is a fiber  
2   based filter.

1           71.    The apparatus of claim 60, wherein the static filter is a  
2   waveguide filter.

1           72.    The apparatus of claim 60, further comprising:  
2           a mode coupler coupled to an optical fiber and configured to create  
3   perturbations in the optical modes in the optical fiber and provide coherent  
4   coupling between a first mode to a second mode in the optical fiber.

1           73.    The apparatus of claim 72, wherein the optical fiber has a  
2   cladding surrounding a core.

1           74.    The apparatus of claim 72, wherein the mode coupler is  
2   selected from an acoustic grating, a UV grating, a bending grating and a  
3   stress induced grating.

1           75.    The apparatus of claim 72, wherein the mode coupler  
2   includes an acoustic wave generator and an acoustic wave propagation  
3   member coupled to the optical fiber.

1           76.    The apparatus of claim 72, wherein the mode coupler couples  
2   a first core mode to a second core mode.

1           77.    The apparatus of claim 72, wherein the mode coupler couples  
2   a core mode to a cladding mode.

1           78.     The apparatus of claim 72, wherein the mode coupler couples  
2 a cladding mode to a core mode.

1           79.     The apparatus of claim 72, wherein the mode coupler couples  
2 a cladding mode to a different cladding mode.

1           80.     The apparatus of claim 72, wherein the mode coupler  
2 includes an acoustic wave generator that produces multiple acoustic signals  
3 with individual controllable strengths and frequencies, each of the acoustic  
4 signals providing a coupling between different modes traveling within the  
5 optical fiber.

1           81.     The apparatus of claim 72, wherein the mode coupler  
2 includes a temperature controlled grating that is temperature tunable.

1           82.     The apparatus of claim 72, wherein the mode coupler  
2 includes a stress induced grating that is stress tunable.

1           83.     The apparatus of claim 72, wherein the mode coupler  
2 includes an acoustic wave generator that produces longitudinal waves.

1           84.     The apparatus of claim 72, wherein the mode coupler  
2 includes an acoustic wave generator that produces torsional waves.

1           85.     The apparatus of claim 72, wherein the mode coupler  
2 includes an acoustic wave generator that produces transverse waves.

1           86.     The apparatus of claim 72, wherein the mode coupler  
2 includes an acoustic wave generator and a wavelength of an optical signal  
3 coupled between two different modes traveling within the optical fiber is  
4 changed by varying the frequency of a signal applied to the acoustic wave  
5 generator.

1           87.     The apparatus of claim 72, wherein the mode coupler  
2 includes an acoustic wave generator and an amount of an optical signal  
3 coupled between two different modes traveling within the optical fiber is  
4 changed by varying the amplitude of a signal applied to the acoustic wave  
5 generator.